

# **Bachelor of Technology**

## **(B Tech)**

### **6<sup>th</sup> Semester**

## **Detailed Syllabus**

### **2019 Batch**

**Department of**  
**Electronics and Communication Engineering**

---



**National Institute of Science and Technology,**  
**Institute Park, Pallur Hills, Berhampur, 761008, Odisha**

**www.nist.edu**

**Department of Electronics and Communication Engineering**

<b>Sixth Semester</b>					
<b>Theory</b>					
Sl. No.	Category	Subject Code	Subject Name	L-T-P	Credit
1	BSC	19CM6BS01T	Optimization Engineering	3-1-0	4
2	PCC	19EC6PC02T	<b>PCC-9:</b> Microwave Engineering	3-0-0	3
3	PCC	19EC6PC03T	<b>PCC-10:</b> Digital Communication Techniques	3-0-0	3
<b>Professional Elective-3:</b>					
4	PEC	19EC6PE01T	Digital System Design	3-0-0	3
		19EC6PE02T	Mobile Communication		
		19EC6PE03T	Digital Image Processing		
		19EC6PE04T	Analog VLSI Design		
<b>Professional Elective-4:</b>					
5	PEC	19EC6PE05T	Machine Learning	3-0-0	3
		19EC6PE06T	Speech Processing		
		19EC6PE07T	Satellite Communication		
		19EC6PE08T	Industrial Communication Protocol		
<b>Open Elective-3: [for other branch students]</b>					
6	OEC	19EC6OE01T	Fundamentals of Satellite Communication	3-0-0	3
		19EC6OE02T	Image Processing Techniques		
		<b>Open Elective-3: [for ECE branch students]</b>			
		19CS6OE01T	Data Analytics		
		19IT6OE01T	Introduction to Operating System		
		19ME6OE01T	Introduction to Hybrid Vehicles		
		19EE6OE01T	Electrical Energy Utilization		
		19EE6OE02T	Introduction to Robotics and Autonomous Vehicles		
		19CE6OE01T	Plastic Waste Management		
19CE6OE02T	Environment and Safety Engineering				
<b>Total Credit (Theory)</b>					<b>19</b>
<b>Practical</b>					
1	PCC	19EC6PC01L	<b>PCC Lab-10:</b> Digital Communication Laboratory	0-0-2	1
2	PCC	19EC6PC02L	<b>PCC Lab-9:</b> Microwave Engineering Laboratory	0-0-2	1
3	PSI	19CM6PS01L	<b>Research/Lab based Project</b>	0-0-3	2
4	HSMC	19CM6HS01L	Business Communication & Interview Skills	0-0-3	2
<b>TOTAL SEMESTER CREDIT</b>					<b>25</b>

<b>Subject Code:</b> 19CM6BS01T	<b>Subject Name:</b> OPTIMIZATION ENGINEERING	<b>L-T-P:</b> 3-1-0	<b>Credit:</b> 4
------------------------------------	--	------------------------	---------------------

**COURSE OBJECTIVES:**

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
2. To develop and promote and promote research interest in applying optimization techniques in problems of Engineering and Technology.
3. To apply the mathematical results and numerical of optimization theory to different Engineering problems.

**SYLLABUS:**

**Module-1: (8hrs)**

Idea of Engineering optimization, Classification of optimization Problems, Optimization Problem and Model Formulation. **Linear programming:** Formulation of LPP, Simplex method, Big-M method, Two-phase Method, Dual Simplex method, Sensitivity analysis in linear programming.

**Module-2: (8hrs)**

**Transportation problems:** Finding an initial basic feasible solution by Northwest Corner rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method.

**Assignment problems:** Hungarian method for solution of Assignment Problems

**Integer Programming:** Integer Programming, Mixed Integer Programming, Branch and Bound method.

**Module-3: (10hrs)**

**Non-linear programming:** Introduction to non-linear programming. Constrained optimization, Multivariable optimization: Method of Lagrange Multipliers, Kuhn-Tucker condition.

**Unconstraint optimization:** Powell's Method, Steepest Descent (Cauchy) Method, Conjugate Gradient (Fletcher-Reeves) Method, Newton's Method.

**Module-4:****(8hrs)**

**Game Theory:** Concept, Game models, two persons zero sum games and their solution, Pure & Mixed Strategy, solution of  $2 \times n$  and  $m \times 2$  games by graphical approach.

**Decision Theory:** Concept, Decision under risk (EMV) & uncertainty.

**Module-5:****(8hrs)**

**Queuing models:** General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

**COURSE OUTCOMES:**

1. Understand importance of optimization of industrial process management.
2. Apply basic concepts of mathematics to formulate an optimization problem.
3. Analyse and appreciate variety of performance measures for various optimization problems

**TEXT BOOKS:**

1. S. S. Rao, *Engineering Optimization*, New Age International Publications.
2. A. Ravindran, D. T. Philips, J. Solberg, *Operations Research- Principle and Practice*, Second edition, Wiley India Pvt Ltd.
3. H.A. Taha, A.M. Natarajan, P. Balasubramanie, A. Tamilarasi, *Operations Research*, Pearson Education, Eighth Edition.

**REFERENCE BOOKS:**

1. S.D. Sharma, *Operations Research*, Kedarnath Publications.
2. F.S. Hiller, G.J. Lieberman, *Operations Research*, Tata McGraw Hill.
3. P.C. Biswal, *Optimization Engineering*, Scitech Publications
4. Prem Kumar Gupta, D.S. Hira, *Operations Research*, S. Chand Publications.

# PROFESSIONAL CORE COURSE

<b>Subject Code:</b> 19EC6PC02T	<b>Subject Name:</b> MICROWAVE ENGINEERING	<b>L-T-P:</b> 3-0-0	<b>Credit:</b> 3
------------------------------------	---	------------------------	---------------------

### **COURSE OBJECTIVE:**

The program is expected to enable the students to:

1. Familiarize with microwave bands and its properties, societal impression and the characteristics of microwave passive components.
2. Impart knowledge on various microwave active components and its principle of operations.
3. Understand the characteristics and the design criteria of microwave transmission media for effective transmission of signals.
4. Understand the design and working of microwave antennas.

#### **Module-1:**

**(10 Hrs.)**

**Introduction to Microwave:** Frequency bands, Applications of Microwaves – Civil, Military and Medical. Microwave Propagation: Line of sight propagation. Attenuation of Microwaves by atmospheric gases and Hazards of EM radiation, Radiation hazard limits, radiation protection.

#### **Microwave Passive Components:**

Power Dividers and Directional Couplers: Basic Properties, The T-Junction Power Divider, Fixed and Precision Variable Attenuator, Phase shifter, Ferrite devices (Isolator, Circulator) (Principle of Operation). Scattering Matrix representation of microwave networks, S-matrix properties, S-parameter for two port network, Signal Flow Graph and application.

#### **Module-2:**

**(10 Hrs.)**

**Microwave Active Devices:** Limitations of low frequency devices at microwave, Microwave Tubes: Klystron Amplifier and Oscillator, Multi-cavity Cylindrical Magnetron: Principle of Operation.

High Frequency Solid State Devices: PIN Diode, Varactor Diode, IMPATT Diode, Gunn Oscillator: Principle and performance, Simple analysis electron-field interaction. Principle of Operation as an amplifier at high frequency, Concept of Doherty Amplifier and its use at high frequency, Mixer: Linear Mixer Operation.

**Module-3:** (8Hrs.)

**High Frequency Transmission lines:** Basic characteristics of high frequency transmission line, Transmission line as circuit element, Quarter wave Transformer, The Smith Chart, Solution of Transmission line problems using Smith Chart, Single Stub and Double Stub matching, Low loss line.

**Module-4:** (10Hrs.)

Rectangular waveguide and field patterns, Principle of power flow through waveguide, Attenuation due to conductor and dielectric losses, Design of rectangular waveguide to support Dominant TE<sub>10</sub> only.

Field Analysis of Co-ax Transmission Lines, TEM mode in Co-ax line. Cylindrical waveguide - Dominant Mode, Design of Cylindrical Waveguide to support Dominant TE<sub>11</sub> mode. Microwave Resonator: Rectangular Waveguide Cavities. Resonant frequencies of Cavity supporting Dominant mode only. Excitation of waveguide and Resonators (principle only).

**Module-5:** (6Hrs.)

Microwave Antennas: Horn Antennas: E- and H- Plane Horns, Radiation Patterns, Pyramidal Horn, Gain of Horn Antenna. Basic principle and application of Parabolic Reflector Antenna.

**COURSE OUTCOME:**

After the completion of the course, students will be able to:

1. Understand the microwave applications and the characteristics and working principle of various microwave passive components.
2. Analyze and calculate different performance parameters of active microwave devices.
3. Analyze and Design the transmission media for effective transmission of microwave signals.
4. Explain the working principle of microwave antennas and design Horn antennas for a given specifications.

### TEXT BOOKS

1. D.M.Pozar, “*Microwave Engineering*”, 2<sup>nd</sup> Edition. John Willy & Sons.
2. Herbert J. Reich, John G. Skalnik, Philip F. Ordnung and H. L. Krauss “*Microwave Principles*”, CBS Publisher, 2018
3. Sammuel Y.Liao, “*Microwave Device and Circuit*”, 3<sup>rd</sup> Edition, Pearson
4. G.S.N.Raju “*Microwave Devices and Circuits*”, Dreamtech Press, 2021
5. Subol Kar, “*Microwave Engineering*”, Universities Press, 2016.

### REFERENCE BOOKS

1. G. S. Raghuvanshi, “*Microwave Engineering*”, CENGAGE Learning, 2012.
2. Sushrut Das, “*Microwave Engineering*”, Oxford University Press, 2014.
3. R.E. Collin, “*Foundation of Microwave Engineering*”, 2<sup>nd</sup> Ed., Wiley Publications, 2007.

### DIGITAL LEARNING RESOURCES

CourseName:	MicrowaveEngineering
CourseLink:	<a href="https://nptel.ac.in/courses/108/103/108103141/">https://nptel.ac.in/courses/108/103/108103141/</a>
CourseInstructor:	Dr.RatnajitBhattacharjee,IIT,Guwahati

CourseName:	MicrowaveTheoryandTechniques
CourseLink:	<a href="https://nptel.ac.in/courses/108/101/108101112/">https://nptel.ac.in/courses/108/101/108101112/</a>
CourseInstructor:	Prof.GirishKumar, IIT,Bombay

<b>Subject Code:</b>	<b>Subject Name:</b>	<b>L-T-P:</b>	<b>Credits:</b>
<b>19EC6PC03T</b>	<b>DIGITAL COMMUNICATION TECHNIQUES</b>	<b>3-0-0</b>	<b>3</b>

### **COURSE OBJECTIVES:**

The objective of this course is to introduce students to

1. Basic concepts of analog to digital converter techniques like sampling, quantization in digital communication systems.
2. Principles and applications of various digital modulation techniques and analyze the error performance of digital modulation techniques.
3. Process of designing the optimum receivers for digital modulation techniques.
4. Analyze and design the digital communication systems using the performance constrains such as power, spectral and error.

### **MODULE - I**

(8 hours)

#### **Digital Representation of Analog Signal**

Digital Representation of Analog Signal, Differential PCM: Predictor, Linear predictor design, Delta Modulation: modulator and demodulator, errors in DM, Adaptive Delta Modulation, Comparison of PCM, DM and ADM.

### **MODULE - II**

(6 hours)

#### **Noise in PCM & DM**

Calculation of Quantization Noise, Output Signal Power, and the Thermal Noise. Output SNR in PCM, Quantization noise in Delta Modulation, output signal power, output SNR, Comparison with PCM and DM

### **MODULE - III**

(8 hours)

**Digital Modulation Technique:** Generation, Transmission, Reception, Spectrum and Geometrical Representation in the Signal Space of BPSK, DPSK, QPSK, QASK, M-ary PSK, BFSK, M-ary FSK, and Minimum Shifting Keying (MSK).

#### MODULE - IV

(6 hours)

**Principle of Digital Data Transmission:** Digital Communication Systems – Source, Line coder, PSD of various line codes, Multiplexer, Regenerative repeater; scrambling, T1 Digital System, Multiplexing T1 lines – The T2, T3 and T4 lines, Pulse shaping – ISI and effect, Nyquist first criterion for zero ISI; Equalizers, Eye Diagram

#### MODULE - V

(8 hours)

A base band signal Receiver, Peak signal to RMS noise output voltage ratio, probability of error, optimum threshold, optimum receiver for both base band and pass band: calculation of optimum filter transfer function, optimum filter realization using Matched filter, Probability error of the matched filter, optimum filter realization using correlator.

The Concept of amount of Information, Average Information, Entropy; Information rate.

#### TEXT BOOKS:

1. H. Taub, D. L Schilling, G. Saha, *Principles of Communication System*, 4<sup>th</sup> Edition, McGraw Hill, 2013, India.
2. B.P. Lathi, Z Ding and Gupta, *Modern Digital and Analogue Communication Systems*, 4<sup>th</sup> Edition, Oxford University Press, 2010, New Delhi.

#### REFERENCE BOOKS:

1. John G. Proakis, Masoud Salehi, *Digital Communications*, 5<sup>th</sup> Edition, McGraw Hill Education, 2014, India.
2. 2. Bernard Sklar, P.K. Ray, *Digital Communications: Fundamentals & Applications*, 2<sup>nd</sup> Edition, Pearson Education, 2009, India.

#### COURSE OUTCOMES:

On Completion of this Subject/ Course the students should be able to:

1. Evaluate the performance of various analog-to-digital conversion techniques in presence of noise and errors.
2. Analyze various digital modulation techniques and compare their generation, transmission and reception techniques.

3. Describe the effect of Inter Symbol Interference (ISI) and equalization techniques to overcome it.
4. Design and realize optimum filters for digital communication.

### **DIGITAL LEARNING RESOURCES**

Course Name	Digital Communication
Course Link	<a href="https://nptel.ac.in/courses/117/101/117101051/">https://nptel.ac.in/courses/117/101/117101051/</a>
Course Instructor	Prof. Bikash Kumar Dey, Electrical Engineering Department, IIT Bombay

Course Name	Modern Digital Communication Techniques
Course Link	<a href="https://nptel.ac.in/courses/117/105/117105144/">https://nptel.ac.in/courses/117/105/117105144/</a>
Course Instructor	Prof. Suvra Sekhar Das, G.S. Sanyal School of Telecommunication, IIT Khargapur

# **PROFESSIONAL**

# **ELECTIVE**

# **COURSE - 3**

<b>Subject Code:</b> 19EC6PE01T	<b>Subject Name:</b> DIGITAL SYSTEM DESIGN	<b>L-T-P:</b> 3-0-0	<b>Credit:</b> 3
------------------------------------	---	------------------------	---------------------

### COURSE OBJECTIVE:

The program is expected to enable the students

1. To study the capabilities of Finite State Machines.
2. To understand the design techniques and timing issues of synchronous sequential circuits.
3. To explore the sequential circuit design using programmable logic devices.
4. To develop different digital systems using Verilog HDL.

### SYLLABUS

#### Module-1: (8 Hours)

**Introduction to FSM and Reduction of State Tables:** Finite state model, State graphs and tables, Capabilities and limitations of FSM, State reduction and assignment, One-Hot Encoding Moore and Mealy state models.

#### Module-2: (12 Hours)

**Synchronous Sequential Circuits and Iterative Networks:** Analysis and Synthesis of Synchronous sequential circuits, Top down and Bottom up Approach to Design, Design Procedure, Design of Serial Adder: using Mealy type FSM, using Moore type FSM, Implementation of the Arbitrator Circuit, Iterative Networks: Design of a parity checker, Design of a comparator, Design of a pattern Detector.

#### Module-3: (8 Hours)

**Sequential Network Design with Programmable Logic Devices (PLDs):** Static Random Access Memory (SRAM), SRAM blocks in PLDs, Design of Sequential Networks using ROMs and PLAs, PALs, Other Sequential PLDs, Programmable Gate Arrays.

#### Module-4: (10 Hours)

**Timings of Sequential Circuit:** Set-up and hold time, Clock Synchronization: Clock skew, Asynchronous inputs to flip fops, Switch debouncing, Pipelining, Retiming, Resource sharing, Maximum frequency of a design.

**Model-5:****(10 Hours)**

**Introduction to HDL:** Introduction to Verilog HDL, Different modeling techniques: Data flow, Behavioral, Structural Models, and Design Examples.

**COURSE OUTCOMES:**

After completion of the course, the student will be able to

1. Understand the various types of FSM and state table reduction technique to design cost effective digital systems.
2. Synthesize different types of synchronous sequential logic circuits using Melay model and Moore model and analyze them to verify the functionality.
3. Develop the skill to design synchronous sequential logic circuits and analyze the timing issues to have an error free design.
4. Assess the technology in the area of PLDs and design of digital systems for real world applications using Verilog HDL.

**TEXT BOOKS:**

1. Charles H. Roth, Jr, “*Fundamentals of Logic Design*”, JPH, 4th Edition, 1999, Mumbai
2. Stephen Brown, Zvonko Vranesic, “*Fundamentals of Digital Logic with Verilog Design*”, Tata McGraw-Hill, 1<sup>st</sup> Edition 2002, New Delhi
3. Diptiman Ray Chaudhuri, “*Digital Circuits: Problems & Solutions (Vol-1 and 2)*”, Platinum Publisher, 2013

**REFERENCE BOOKS:**

1. John Wakerley, “*Digital Design: Principles and Practices*”, Pearson Education, 4th Edition, 2006
2. Moris M. Mano, “*Digital Design*”, Pearson Education, 3rd Edition, 2002, Delhi
3. Samir Palnitkar, “*Verilog HDL: A Guide to Digital Design and Synthesis*”, Prentice Hall PTR, 2nd Edition, 2004, Delhi

**DIGITAL LEARNING RESOURCES:**

Course Name	<b>Digital System Design</b>
Course Link	<a href="https://nptel.ac.in/courses/108/106/108106177/">https://nptel.ac.in/courses/108/106/108106177/</a>
Course Instructor	Prof. NeerajGoel, Department of Computer ScienceEngineering, IIT Ropar
Course Name	<b>Digital System Design</b>
Course Link	<a href="https://nptel.ac.in/courses/117/105/117105080/">https://nptel.ac.in/courses/117/105/117105080/</a>
Course Instructor	Prof. D. Roychoudhury, Department of ECE, IIT Kharagpur
Course Name	Hardware Modeling using Verilog
Course Link	<a href="https://nptel.ac.in/courses/noc/courses/noc17/SEM2/noc17-cs21">https://nptel.ac.in/courses/noc/courses/noc17/SEM2/noc17-cs21</a>
Course Instructor	Prof. Indranil Sengupta, Dept of ECE, IIT Kharagpur

<b>Subject Code:</b> 19EC6PE02T	<b>Subject Name:</b> MOBILE COMMUNICATION	<b>L-T-P:</b> 3-0-0	<b>Credit:</b> 3
------------------------------------	--	------------------------	---------------------

### COURSE OBJECTIVES:

The purpose of this course is to introduce students to

1. Basic cellular concepts and capacity enhancement techniques like sectoring, cell splitting, microcell, picocell etc.
2. Analysis of various channel models and fading characteristics.
3. Various multiple access techniques and spread spectrum techniques.
4. Principles and applications of various cellular mobile communication systems.

### MODULE-I

**(8 Hrs)**

**Fundamentals of Cellular Communications-** Introduction, Cellular Systems: Hexagonal Cell Geometry, Frequency reuse, channel Assignment; Handoff Strategies; Interfaces and System Capacity-Co-channel Interference Ratio, Cellular System Design in Worst-Case Scenario with an Omni directional Antenna, Co-channel Interference Reduction, ACI, Cell Splitting; Sectoring, Directional Antennas in Seven-Cell Reuse Pattern; Microcell & Picocell Zone Concept.

### MODULE-II

**(8 Hrs)**

**Large Scale Propagation:** Introduction, Free Space Propagation Model; Basic propagation mechanisms, Free-space Attenuation, Attenuation over Reflecting Surfaces; Outdoor propagation Path Loss Models; Indoor Propagation Path Loss Model

**Small Scale Propagation:** small scale multi path propagation; Characteristics of Wireless Channel, Parameters of multi path channels; types of multi path fading; Signal Fading Statistics.

### MODULE-III

**(6 Hrs)**

**Mobile Wireless Communication Systems-** GSM- Network architecture, Frame structure, channel organization, call setup procedure, Fourth Generation Systems: Introduction, Vision, Features and challenges, Applications, Technologies in 4G.

#### MODULE-IV

(6 Hrs)

**Multiple Access Techniques-** Introduction, Narrowband Channelized Systems, Comparisons of FDMA, TDMA and DS-CDMA, Comparison of DS-CDMA vs. TDMA; Spectral Efficiency, System Capacity, Capacity of a DS-CDMA System.

#### MODULE-V

(8 Hrs)

**Spread Spectrum and Equalization Techniques-** Spread Spectrum(SS) Systems- Introduction, Concept of Spread Spectrum, System Processing Gain, Frequency-Hopping Spread Spectrum Systems. Introduction to Equalization, diversity techniques (space, polarization, time, frequency)

#### COURSE OUTCOME:

On Completion of this Subject/ Course the students should be able to:

1. Identify and discuss the fundamental operational and design problems of cellular mobile communication systems.
2. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling
3. Explore various wireless mobile communication standards and analyze their system performance.
4. Analyze various multiple access techniques and compare their system performance in terms of capacity and spectral efficiency.

#### TEXT BOOKS:

1. V K Garg, *Wireless Communication and Networking*, Essential Reading, Morgan Kaufman Publishers, 2008, India.
2. T S Rappaport, *Wireless Communications*, 2nd Edition, Pearson Education, 2018, India.

#### REFERENCE BOOKS:

1. Upena Dalal and Manoj K. Shukla, *Wireless and Mobile Communication*, Oxford University Press, 2016, India.
2. W C Y Lee, *Mobile Communication Engineering – Theory and Applications*, 2<sup>nd</sup> Edition, McGraw Hill Education, 2017, India.
3. Andreas F Molish, *“Wireless Communications”*, 2nd Edition, Wiley, 2013, India.

4. A Goldsmith, *Wireless communication*, 1<sup>st</sup> Edition, Cambridge University Press, 2009, India.

### **DIGITAL LEARNING RESOURCES**

Course Name	Introduction to Wireless and Cellular Communication
Course Link	<a href="https://nptel.ac.in/courses/106/106/106106167/">https://nptel.ac.in/courses/106/106/106106167/</a>
Course Instructor	Prof. David Koilpillai, Department of Electrical Engineering , IIT Madras

<b>Subject Code:</b> 19EC6PE03T	<b>Subject Name:</b> DIGITAL IMAGE PROCESSING	<b>L-T-P:</b> 3-0-0	<b>Credit:</b> 3
------------------------------------	--	------------------------	---------------------

### COURSE OBJECTIVE:

The program is expected to enable the students to

1. Gain an insight into the various analytical methods and transforms used in image processing.
2. Familiarize with image enhancement and restoration techniques.
3. Mathematical modeling of different image compression techniques and their applications.
4. Understand the Concept of color image processing and morphological operations on gray image.

### SYLLABUS

#### Module- 1

**(8 Hours)**

**Digital Image Fundamentals:** Digital Image Processing: Introduction, Background of image processing, Fundamental steps in image processing, Elements of digital image processing systems. Digital image representation, Sampling and quantization, Relationship Between pixels, Imaging geometry: Translation, Rotation, Perspective Transformation.

**Properties and Applications of Image Transforms:** Fourier Transform, Discrete Fourier Transform, Fast Fourier Transform, Discrete Cosine Transform, Walsh Transform, Hadamard Transform, Hotelling Transform, Fundamentals on wavelet transform.

#### Module- 2

**(8 Hours)**

**Image Enhancement:** Enhancement in spatial domain: Basic gray level transformations, Histogram processing, Smoothing and Sharpening of Spatial Filters. Enhancement in frequency domain: Introduction to filtering in frequency domain, Smoothing and Sharpening of frequency domain filters.

### Module-3

(8 Hours)

#### Image Restoration and Reconstruction:

Image restoration/degradation model, Noise models in image processing, Restoration in the presence of noise only, Periodic noise reduction by frequency domain filtering, Linear position invariant degradations, Estimating the degradation function, Inverse filtering, Wiener filtering, Constrained least squares restoration.

### Module- 4

(6 Hours)

#### Image compression:

Introduction and motivation, Fundamental concepts: Data redundancy (coding redundancy, inter pixel redundancy and psycho visual redundancy), Fidelity criteria, Image compression models, Image compression standards, Elements of information theory. Image compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-Length Coding, Bit plane coding.

### Module-5

(6 Hours)

**Color Image Processing:** Color fundamentals, Conversion of color image to gray scale image, Color model (RGB, HSI, HSV, HLS, CMK, CMYK).

**Morphological Image Processing:** Morphological Image Processing: Preliminaries, Erosion, Dilation, Opening and Closing, hit or Miss transformation, Boundary extraction, Hole filling, Extraction of connected components, Thinning, Thickening.

#### COURSE OUTCOMES:

On Completion of this course, the students should be able to:

1. Understand the need for different types of image transforms and their properties for processing of gray and color image data.
2. Implement the signal processing algorithms and techniques in image enhancement, image restoration, Morphology and Image Compression.
3. Implement basic image processing algorithms in MATLAB.
4. Understand practical scope of digital image processing for most of the work currently underway in this field.

**TEXT BOOKS:**

1. R.C. Gonzalez, R.E. Woods, Digital Image Processing, 3rd Edition, Pearson Education, 2007, New Delhi.
2. S. Sridhar, Digital Image Processing, 2<sup>nd</sup> Edition, Oxford University Press, 2016, New Delhi.

**REFERENCE BOOKS:**

1. Rafael C. Gonzalez, Richard E. Woods Digital Image Processing using MATLAB, Seventh Edition , Pearson Education, Inc, 2004, New Delhi.
2. William K. Pratt, Digital Image Processing, 4<sup>th</sup> Edition, Wiley, 2002, New York.
3. Anil K. Jain, 'Fundamentals of Digital Image Processing', 1<sup>st</sup> Edition, Pearson 2019, New Delhi.
4. B. Chanda, Dutta D. Majumder, Digital Image Processing And Analysis, 2<sup>nd</sup> Edition ,PHI, 2011 , New Delhi.

**DIGITAL LEARNING RESOURCES:**

Course Name	DIGITAL IMAGE PROCESSING
Course Link	<a href="https://nptel.ac.in/courses/117/105/117105135/">https://nptel.ac.in/courses/117/105/117105135/</a>
Course Instructor	Prof. P.K. Biswas , Department of Electronics & Electrical Communication Engineering, I.I.T, Kharagpur

<b>Subject Code:</b> <b>19EC6PE04T</b>	<b>Subject Name:</b> <b>ANALOG VLSI DESIGN</b>	<b>L-T-P:</b> <b>3-0-0</b>	<b>Credit:</b> <b>3</b>
---	---	-------------------------------	----------------------------

### **COURSE OBJECTIVE:**

During learning the course student should able to

1. Understand the concept of Robust Analog Design and Single-Stage Amplifiers
2. Learn the concept of Differential Amplifier and Passive and Active Current Mirrors.
3. Learn the concept of Bandgap References and Operational Amplifier.
4. Understand the concept of Stability as well as Frequency Compensation and also learn the design methodology of amplifiers

### **SYLLABUS**

#### **Module – I**

**(10 Hours)**

**Introduction to Analog Design:** General Concepts, Levels of Abstraction, Robust Analog Design.

**Single-Stage Amplifiers:** Basic Concepts, Common-Source Stage, Common-Source Stage with Resistive Load, CS Stage with Diode-Connected Load, CS Stage with Current- Source Load, CS Stage with Triode Load, CS Stage with Source Degeneration, Source Follower, Common-Gate Stage, Cascode Stage, Folded Cascode.

#### **Module – II**

**(10 Hours)**

**Differential Amplifiers:** Single-Ended and Differential Operation, Basic Differential Pair, Qualitative Analysis, Quantitative Analysis, Common-Mode Response, Differential Pair with MOS Loads.

**Passive and Active Current Mirrors:** Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors, Large-Signal Analysis, Small-Signal Analysis, Common-Mode Properties.

#### **Module – III**

**(10 Hours)**

**Bandgap References:** General Considerations, Supply-Independent Biasing, Temperature-Independent References, Negative-TC Voltage, Positive-TC Voltage, Bandgap Reference, PTAT current generation.

**Operational Amplifiers:** General Considerations, Performance Parameters, One-Stage Op Amps, Two-Stage Op Amps, Gain Boosting, Slew Rate, Power Supply Rejection

**Module – IV** **(6Hours)**

**Stability and Frequency Compensation:** General Considerations, Multipole System, Phase Margin, Frequency Compensation. Compensation of Two-Stage OpAmp

**Module – V** **(6 Hours)**

**Design methodology of Amplifier:** Design methodology with examples of Single Stage Amplifiers (CS) with resistive and MOS load, Differential Amplifier with resistive and active load, two stage operational Amplifier.

### **COURSE OUTCOME**

After completion of the course, the student will be able to

1. Analyze single stage amplifiers with different loads.
2. Acquire knowledge about differential amplifier with different loads and also analyze the concept of Passive and Active Current Mirrors.
3. Analyze the concept of Bandgap References and Operational Amplifier
4. Design and evaluate the performance of CMOS operational amplifiers with biasing as well as stability

### **TEXT BOOKS:**

1. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, 2017.
2. Phillip E. Allen, Douglas R. Holberg, *CMOS Analog Circuit Design*, 3rd Edition, Oxford University Press, 2013.

### **REFERENCE BOOKS:**

1. David A Johns, Ken Martin, *Analog Integrated Circuit Design*, 2nd Edition, Wiley India Pvt. Limited, 2013.
2. Paul R Gray and R G Meyer, *Analysis and design of analog integrated circuits*, 6th Edition, Wiley, 2019.

**DIGITAL LEARNING RESOURCES:**

Course Name	Analog IC Design
Course Link	1) <a href="https://nptel.ac.in/courses/117/106/117106030/">https://nptel.ac.in/courses/117/106/117106030/</a>
Course Instructor	Prof. S. Aniruddhan  IIT Madras
Course Name	CMOS Analog VLSI Design
Course Link	<a href="https://nptel.ac.in/courses/117/101/117101105/">https://nptel.ac.in/courses/117/101/117101105/</a>
Course Instructor	Prof. A.N. Chandorkar   IIT Bombay

# PROFESSIONAL ELECTIVE COURSE - 4

<b>Course Code:</b> <b>19EC6PE05T</b>	<b>Course Name:</b> <b>MACHINE LEARNING</b>	<b>L-T-P:</b> <b>3-0-0</b>	<b>Credit:</b> <b>3</b>
--	--	-------------------------------	----------------------------

### **COURSE OBJECTIVE:**

1. Develop a concise knowledge on understanding of the fundamental concept of machine learning.
2. Understand the different learning algorithms and implement them.
3. Gain experience in applying machine learning algorithms to real world problems.

#### **Module-1: [6 Hrs]**

Introduction to Machine Learning, Model Preparation, Modelling and Evaluation, Human learning versus machine learning, types of machine learning, applications of machine learning, tools for machine learning, Machine Learning Activities, Data structures for machine learning, Data Pre-processing, selecting a model, training a model, model representation and interpretability, evaluating performance of a model, improving performance of a model, Learning theory, Hypothesis and target class, Hilbert space, Inductive bias and bias-variance tradeoff.

#### **Module-2: [6 Hrs]**

Feature Engineering, Bayesian Concept Learning, Introduction to feature engineering, feature transformation, feature subset selection, Importance of Bayesian methods, Bayes' theorem, concept learning through Bayes' theorem, Bayesian Belief Network

#### **Module-3: [12 Hrs]**

Supervised Learning –Classification, Regression, Example of supervised learning, classification model, classification learning steps, common classification algorithms – KNN, Decision trees random forest, SVM, example of regression, common regression algorithms,

#### **Module-4: [12 Hrs]**

Unsupervised Learning –Clustering, pattern finding using association rules, Unsupervised learning versus supervised learning, applications of unsupervised learning, clustering and its types, Apriori algorithm for association rule learning

**Module-5:**

**[4 Hrs]**

Neural Network: Understanding the biological neuron, exploring artificial neuron, types of activation functions, early implementation of artificial neural network, architectures of neural network, learning process in artificial neural network, backpropagation, Overview of Deep Learning

**COURSE OUTCOME:**

1. Equip students with knowledge of fundamentals concepts in machine learning.
2. Ability to analyze and validate different learning algorithms.
3. Fine tune machine learning algorithms and evaluate models generated from data.

**TEXTBOOKS:**

1. Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, “Machine Learning”, Pearson Education
2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2010..

**REFERENCE BOOKS:**

1. J. Friedman, T. Hastie, and R. Tibshirani. The elements of statistical learning. Vol. 1, no. 10. New York: Springer series in statistics, 2001.
2. S. Shalev-Shwartz, and S. Ben-David. Understanding machine learning: From theory to algorithms. Cambridge university press, 2014.

**DIGITAL LEARNING RESOURCES**

Course Name	<a href="#">Introduction to Machine Learning</a>
Course Link	<a href="https://nptel.ac.in/courses/106/106/106106139/">https://nptel.ac.in/courses/106/106/106106139/</a>
Course Instructor	Dr. Balaraman Ravindran, IIT Madras

<b>Course Code:</b> <b>19EC6PE06T</b>	<b>Course Name:</b> <b>SPEECH PROCESSING</b>	<b>L-T-P:</b> <b>3-0-0</b>	<b>Credit:</b> <b>3</b>
--	---	-------------------------------	----------------------------

### COURSE OBJECTIVE:

The purpose of this course is to introduce students to

1. Models of speech production and acoustic phonetics
2. Analysis of speech signals in time and frequency domain models.
3. Principles of speech recognition, speech synthesis and their applications
4. Linear predictive coding analysis of speech signal.

### SYLLABUS

#### Module-1

(8 Hrs.)

**Digital Models for Speech Signal:** Fundamentals of Speech - Digital Speech Processing, Process of speech production, Acoustics theory of speech production, Lossless Tube models, Digital models for speech signals.

#### Module-2

(8 Hrs.)

**Time Domain Models for Speech Processing:** Introduction to Time domain Parameters of speech signal, Time-dependent processing of speech, Short-time energy and average magnitude, Short-time average zero crossing rate, Short-time Autocorrelation function, Short-time average magnitude difference function, Pitch frequency, Pitch contour, Pitch period estimation using autocorrelation.

#### Module-3

(8 Hrs.)

**Frequency Domain Method for Speech Processing:** Short time Fourier analysis, Fourier transform, Linear filtering interpretation, Filter bank summation method and overlap addition method for short-time synthesis, Implementation of the Filter bank summation method using FFT, Spectrographic display, Pitch detection.

#### Module-4

(8 Hrs.)

**Cepstrum and Homomorphic Speech Processing:** Introduction, Homomorphic systems for convolution, Properties of the complex Cepstrum, Computational Considerations, Complex Cepstrum of speech, Pitch detection, Formant Estimation, Homomorphic vocoder.

## Module-5

(8 Hrs.)

**Linear Predictive Analysis of speech:** Basic principles of Linear Prediction analysis: Autocorrelation method, Covariance method, Computational gain of the model, Solution of LPC equations: Cholesky method, Durbin's Recursive algorithm, Lattice Formulations and Solutions, Prediction Error Signal, Relation of linear predictive analysis to lossless tube models, Applications of LPC Parameters.

## COURSE OUTCOME

On completion of this course, students should be able to:

1. Demonstrate basic knowledge in speech production mechanism, phoneme classification, digital models for speech production, Homomorphic speech processing and LPC analysis.
2. Execute the applications of signal processing theory for estimation of speech parameters in time and frequency domain including pitch and formants.
3. Analyze the strengths and limitations of speech synthesis technologies.
4. Analyze application of speech processing in speech compression, speech recognition, and speech synthesis.

## TEXT BOOKS

1. L.R. Rabiner, R.W. Schafer, *Digital Processing of Speech Signals*, 1<sup>st</sup> Edition, Pearson Publication, 2003, India
2. Thomas F, Quatieri, *Discrete-Time Speech Signal Processing*, 1<sup>st</sup> Edition, Pearson Education, 2004, India

## REFERENCE BOOKS

1. S.D. Apte, *Speech and Audio processing*, 1<sup>st</sup> Edition, Willey Precise publication, 2019, India
2. L. Rabiner, B. H. Juang, B.Yegnararayana, *Fundamentals of Speech Recognition*, 1<sup>st</sup> Edition, Pearson publication, 2008, India.

## DIGITAL LEARNING RESOURCES

Course Name	Digital speech processing
Course Link	<a href="https://nptel.ac.in/courses/117105145/">https://nptel.ac.in/courses/117105145/</a>
Course Instructor	Prof. Shyamal Kumar Das Mandal, Department of ECE , IIT Kharagpur

<b>Subject Code:</b> 19EC6PE07T	<b>Subject Name:</b> SATELLITE COMMUNICATION	<b>L-T-P:</b> 3-0-0	<b>Credit:</b> 3
------------------------------------	---	------------------------	---------------------

### COURSE OBJECTIVE:

The purpose of this course is to introduce students to

1. Educate students with a firm foundation in orbital mechanics and satellite launches.
2. Evaluate the impact of interference on the satellite communication and complete link design.
3. Comprehend multiple access techniques for satellite communication.
4. Design Earth Station antennas and educate them on a variety of useful satellite applications..

### SYLLABUS

#### Module-1

**(10 Hours)**

**Introduction to satellite communication:** Overview of satellite communications, General structure of satellite communication, Satellite frequency allocation and band spectrum, Satellite orbits – Performance characteristics of different altitude satellites (GEO, MEO and LEO satellite systems)

**Orbital mechanics:** Introduction, Kepler’s laws of planetary motion, Orbital parameters, look angle determination, Launches and Launch vehicle, Orbital effects in communication system performance.

**Satellite subsystem:** Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System (TT&C), Power System, Satellite antennas, Communications subsystem, Transponders

#### Module-2

**(8 Hours)**

**Satellite Link Design:** Basics of transmission theory, system noise temperature and G/T ratio, Uplink and Downlink design, design of satellite links for specified (C/N) performance.

### Module-3

(8 Hours)

**Multiple Accesses:** Multiplexing techniques for satellite links, Comprehensive study on FDMA, TDMA and CDMA; Spread Spectrum Transmission and Reception; Estimating Channel requirements, SPADE, Random access

**Propagation on satellite:** Earth paths and influence on link design; Quantifying attenuation and depolarization, hydrometric & non hydrometric effects, ionosphere effects, rain and ice effects.

### Module-4

(8 Hours)

**Satellite Antennas:** Types of antenna and relationships; Basic Antennas Theory – linear, rectangular & circular aperture; Gain, pointing loss.

**Earth station Technology:** Earth station design; Design of large antennas – Cassegrain antennas, optimizing gain of large antenna, antenna temperature, feed system for large cassegrain antennas.

**Design of small earth station antennas:** Front fed paraboloid reflector antennas, offset fed antennas, beam steering, Global Beam Antenna, equipment for earth station

### Module-5

(6 Hours)

**Application of Satellite communication:** Overview of VSAT systems, Network architectures, direct broad casting TV.

**Other Satellite services:** Fundamentals of mobile communication satellite.

### COURSE OUTCOME:

After completion of the course, the student will be able to

1. Explain the basic concepts of orbit mechanics and satellite Launching.
2. Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.
3. Classify various access methods and comprehend satellite link propagation impairments.
4. Explain the fundamentals of earth station technology and the role of satellites in various applications

**TEXT BOOKS:**

1. T. Pratt, C. Bostian, *Satellite Communication*, 2nd Edition, John Wiley Co.,2003,India
2. R.N.Mutagi, *Satellite Communication: Principles & Applications*, 1st Edition, Oxford University Press, 2016,India

**REFERENCE BOOKS:**

1. Dennis Roddy, *Satellite Communications*, 2nd Edition, McGraw Hill, 1996,India
2. M. Richcharia, *Satellite Communications: Design Principles*, 2nd Edition, BSP, 2003,India
3. Tri T. Ha, *Digital Satellite Communication*, Special Indian Edition, Tata McGraw- Hill, 2009, India

**DIGITAL LEARNING RESOURCES:**

Course Name	Satellite Communication Systems
Course Link	<a href="https://nptel.ac.in/courses/117/105/117105131/">https://nptel.ac.in/courses/117/105/117105131/</a>
Course Instructor	<b>Prof. Kalyankumar Bandyopadhyay</b>

<b>Course Code:</b> <b>19EC6PE08T</b>	<b>Course Name:</b> <b>Industrial Communication Protocol</b>	<b>L-T-P:</b> <b>3-0-0</b>	<b>Credit:</b> <b>3</b>
--	---	-------------------------------	----------------------------

**/// only title approved but not Syllabus, it will be updated in next BOS//**

# **Open Elective Course**

## **[OEC - 3]**

### **For other Branch**

### **Students**

<b>Subject Code:</b> 19EC6OE01T	<b>Subject Name:</b> FUNDAMENTAL OF SATELLITE COMMUNICATION	<b>L-T-P:</b> 3-0-0	<b>Credit:</b> 3
------------------------------------	---	------------------------	---------------------

### **COURSE OBJECTIVE:**

The purpose of this course is to introduce students to

1. Make the students understand the basic concept in the field of Satellite Communication
2. Understand the design of satellite links
3. Gain knowledge about the Satellite Access schemes.
4. Comprehend the details of earth stations design and various useful satellite applications

### **SYLLABUS**

#### **Module-1**

**(10 Hours)**

**Introduction to satellite communication:** Overview of satellite communications, General structure of satellite communication, Satellite frequency allocation and band spectrum, Satellite orbits – Performance characteristics of different altitude satellites (GEO, MEO and LEO satellite systems)

**Orbital mechanics:** Introduction, Kepler’s laws of planetary motion, Orbital parameters, look angle determination, Launches and Launch vehicle, Orbital effects in communication system performance.

**Satellite subsystem:** Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System(TT&C), Power System, Satellite antennas, Communications subsystem, Transponders

#### **Module-2**

**(8 Hours)**

**Satellite Link Design:** Basics of transmission theory, system noise temperature and G/T ratio, Uplink and Downlink design, design of satellite links for specified (C/N) performance.

### Module-3

(8 Hours)

**Multiple Accesses:** Multiplexing techniques for satellite links, Comprehensive study on FDMA, TDMA and CDMA; Spread Spectrum Transmission and Reception

**Propagation on satellite:** Earth paths and influence on link design; Quantifying attenuation and depolarization, hydrometric & non hydrometric effects, ionosphere effects, rain and ice effects.

### Module-4

(6 Hours)

**Satellite Antennas:** Types of antenna and relationships; Basic Antennas Theory – linear, rectangular & circular aperture; Gain, pointing loss.

**Earth station Technology:** Earth station design; Design of large antennas – Cassegrain antennas

### Module-5

(6 Hours)

**Application of Satellite communication:** Overview of VSAT systems, Network architectures, direct broad casting TV.

**Other Satellite services:** Fundamentals of mobile communication satellite.

### COURSE OUTCOME:

After completion of the course, the student will be able to

1. Explain the basic concepts of orbit mechanics and satellite Launching
2. Analyze the design of satellite links for specified C/N with system design examples
3. Understand the various multiple access schemes for satellite communication systems, as well as the satellite link propagation impairments
4. Explain the fundamentals of earth station technology and the role of satellites in various applications

### TEXT BOOKS:

1. T. Pratt, C. Bostian, *Satellite Communication*, 2nd Edition John Wiley Co.,2003,India
2. R.N.Mutagi, *Satellite Communication: Principles & Applications*, 1st Edition, Oxford University Press, 2016, India

**REFERENCE BOOKS:**

1. Dennis Roddy, *Satellite Communications*, 2nd Edition, McGraw Hill, 1996, India
2. M. Richcharia, *Satellite Communications: Design Principles*, 2nd Edition, BSP, 2003, India
3. Tri T. Ha, *Digital Satellite Communication*, Special Indian Edition, Tata McGraw- Hill, 2009, India

**DIGITAL LEARNING RESOURCES:**

Course Name	Satellite Communication Systems
Course Link	<a href="https://nptel.ac.in/courses/117/105/117105131/">https://nptel.ac.in/courses/117/105/117105131/</a>
Course Instructor	<b>Prof. KalyankumarBandyopadhyay</b>

Subject Code:	Subject Name:	L-T-P	Credits
<b>19EC60E02T</b>	<b>IMAGE PROCESSING TECHNIQUES</b>	<b>3-0-0</b>	<b>3</b>

### **COURSE OBJECTIVE:**

The program is expected to enable the students to

1. Gain an insight into the various analytical methods used in image processing.
2. Familiarize with image enhancement and restoration techniques.
3. Mathematical modeling of different image compression techniques and their applications.
4. Understand the Concept of color image processing and morphological operations on gray image.

### **SYLLABUS**

#### **Module- 1**

**(8 Hours)**

**Introduction:** Introduction: Background of image processing, Fundamental steps in image processing, Elements of digital image processing systems. Digital image representation, Sampling and quantization, Relationship between pixels: Neighbours, adjacency, connectivity, regions, boundaries and distance measure, Image geometry: translation, rotation, perspective transformation.

#### **Module- 2**

**(8 Hours)**

**Image Enhancement:** Enhancement in spatial domain: Point Processing: Log, Power law, Image Negatives, Piecewise linear transformation, Spatial correlation and convolution Histogram processing. Smoothing and Sharpening of Spatial Filters.

Enhancement in frequency domain: Introduction to filtering in frequency domain, Smoothing and Sharpening of frequency domain filters.

#### **Module-3**

**(8 Hours)**

**Image Restoration and Reconstruction:** Image Restoration: Degradation model, Restoration in presence of noise only – spatial filtering, Linear position invariant degradations, Estimating degradation functions, Inverse filtering, Wiener filtering.

**Color Image Processing:** Color fundamentals, Conversion of color image to gray scale image, Color model (RGB, HSI, HSV, HLS, CMK, CMYK).

#### **Module- 4**

**(6 Hours)**

**Image compression:** Introduction and motivation, Fundamental concepts: Data redundancy (coding redundancy, inter pixel redundancy and psycho visual redundancy), Fidelity criteria, Image compression models, Image compression standards, Elements of information theory. Image compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-Length Coding, Bit plane coding.

#### **Module-5**

**(6 Hours)**

**Morphological Image Processing:** Morphological Image Processing: Preliminaries, Erosion, Dilation, Opening and Closing, hit or Miss transformation, Boundary extraction, Hole filling, Extraction of connected components, Thinning, Thickening.

#### **COURSE OUTCOMES:**

On Completion of this course, the students should be able to:

1. Understand the need for different types of image transforms and their properties for processing of gray and color image data.
2. Implement the signal processing algorithms and techniques in image enhancement, image restoration, Morphology and Image Compression.
3. Implement basic image processing algorithms in MATLAB.
4. Understand practical scope of digital image processing for most of the work currently underway in this field.

#### **TEXT BOOKS:**

1. R.C. Gonzalez, R.E. Woods, Digital Image Processing, 3rd Edition, Pearson Education, 2007, New Delhi.
2. S. Sridhar, Digital Image Processing, 2<sup>nd</sup> Edition, Oxford University Press, 2016, New Delhi.

#### **REFERENCE BOOKS:**

1. Rafael C. Gonzalez, Richard E. Woods Digital Image Processing using MATLAB, Seventh Edition , Pearson Education, Inc, 2004, New Delhi.
2. William K. Pratt, Digital Image Processing, 4<sup>th</sup> Edition, Wiley, 2002, New York.

3. Anil K. Jain, 'Fundamentals of Digital Image Processing', 1<sup>st</sup> Edition, Pearson 2019, New Delhi.
4. B. Chanda, Dutta D. Majumder, Digital Image Processing And Analysis, 2<sup>nd</sup> Edition, PHI, 2011, New Delhi.

**DIGITAL LEARNING RESOURCES:**

Course Name	DIGITAL IMAGE PROCESSING
Course Link	<a href="https://nptel.ac.in/courses/117/105/117105135/">https://nptel.ac.in/courses/117/105/117105135/</a>
Course Instructor	Prof. P.K. Biswas, Department of Electronics & Electrical Communication Engineering, I.I.T, Kharagpur

# Open Elective Course— 3 For ECE Branch Students

<b>Course Code:</b> <b>19CS6OE01T</b>	<b>Course Name:</b> <b>Data Analytics</b>	<b>L-T-P</b> <b>3- 0- 0</b>	<b>Credit :</b> <b>3</b>
--	--	--------------------------------	-----------------------------

### **COURSE OBJECTIVE:**

To optimize business decisions and create competitive advantage with Big Data analytics

1. To explore the concepts regression and classification.
2. To learn to analyze the complexity of different techniques.
3. To understand the various additive models and boosting techniques.
4. To understand the Neural Networks, Support Vector Machines, and K-nearest Neighbor.

#### **Module: 01**

**[8 Hours]**

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection , Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression , Perceptron learning algorithm.

#### **Module: 02**

**[8 Hours]**

Model Assessment and Selection : Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate, Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation ,Boot strap methods, conditional or expected test error.

#### **Module: 03**

**[8 Hours]**

Additive Models, Trees, and Boosting: Generalized additive models, Regression and classification trees , Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting ,Examples ( Spam data, California housing , New Zealand fish, Demographic data).

#### **Module: 04**

**[8 Hours]**

Neural Networks(NN) , Support Vector Machines(SVM),and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers( Image Scene Classification)

**Module: 05**

**[8 Hours]**

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis. (II) Inferential Statistics and Prescriptive analytics.

**TEXT BOOKS:**

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning Data
2. Mining, Inference, and Prediction, Second Edition, Springer Verlag, 2009.
3. G.James, D.Witten, T.Hastie, R.Tibshirani-An introduction to statistical learning with applications in R, Springer, 2013.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall Of India, 2010, (Chapter-19).

**REFERENCES**

1. C.M. Bishop –Pattern Recognition and Machine Learning, Springer, 2006
2. L. Wasserman-All of statistics.

**DIGITAL LEARNING RESOURCES**

Course Name	Data Analytics with Python
Course Link	Computer Science and Engineering - NOC:Data Analytics with Python
Course Instructor	Prof. A. Ramesh, IIT Roorkee

<b>Course Code:</b> 19IT6OE01T	<b>Course Name:</b> Introduction to Operating System	<b>L-T-P</b> <b>3- 0- 0</b>	<b>Credit :</b> <b>3</b>
-----------------------------------	---	--------------------------------	-----------------------------

**COURSE OBJECTIVES:**

1. Recognize the concepts and principles of operating systems.
2. Provide comprehensive introduction to understand the underlying principles, techniques and approaches which constitute a coherent body of knowledge in operating systems.
3. To teach understanding how the various elements that underlie operating system interact and provides services for execution of application software.

**Module-01:**

**[8 Hrs]**

**Overview of operating systems:** computer system organization, computer system architecture, operating system operations, Need of Process/Memory/Storage Management, Protection and security, Distributed systems, Real-Time Embedded Systems. Operating systems services, User Operating System Interface, Systems calls and its types, operating system structure.

**Module-02:**

**Process Concept;** Process Scheduling; Operations on Processes; Interprocess Communication; Thread; Multithreading models;

**Module-03:**

**[8 Hrs]**

**Scheduling Criteria,** Algorithms (FCFS, SJF, SRTF, Round Robin, Priority, Multi-level Queue and Feedback Queue), Thread scheduling. The Critical- section problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical problems of synchronization, monitors

**Module-04:**

**[8 Hrs]**

System model; Deadlock Characterization; Methods for Handling Deadlock (Deadlock prevention, detection and Avoidance, recovery); Swapping; Contiguous memory allocation; Paging; Structure of the page table; Segmentation; Virtual memory, demand paging, Copy on write, page- Replacement algorithms (FIFO, LRU, LFU, Optimal Page Replacement)

**Module-05:**

**[8 Hrs]**

File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing and Protection, File system structure, File System Implementation, Directory Implementation, Allocation Methods. Overview of Mass-storage structure, disk structure, disk attachment, disk scheduling, swap-space management

**COURSE OUTCOME:**

1. Identify basic components of operating system.
2. Conceptualize synchronization amongst various components of a typical operating system.
3. Understand and simulate activities of various operating system components.
4. Correlate basic concepts of operating system with an existing operating system.

**TEXT BOOK:**

1. Abraham Silberschatz, Peter Baer Galvin & Greg Gagne “Operating System Concepts”, 8<sup>th</sup> edition.
2. John Wiley & Sons William Stallings, “Operating Systems – Internals and Design Principles”, 5/e, Pearson.
3. Charles Crowley, “Operating Systems: A Design-Oriented Approach”, Tata McGraw Hill Co.,1998 edition.
4. Andrew S. Tanenbaum, “Modern Operating Systems”, 2nd edition, 1995, PHI.

**DIGITAL LEARNING RESOURCES**

Course Name	Operating System Fundamentals
Course Link	<a href="https://nptel.ac.in/courses/106/105/106105214/">https://nptel.ac.in/courses/106/105/106105214/</a>
Course Instructor	Prof. Santanu Chattopadhyay IIT Kharagpur

<b>Course Code:</b> <b>19ME6OE01T</b>	<b>Course Name:</b> <b>Introduction to Hybrid Vehicles</b>	<b>L-T-P</b> <b>3- 0- 0</b>	<b>Credit</b> <b>3</b>
--	---	--------------------------------	---------------------------

**COURSE OBJECTIVE:**

1. Understand the basic functional blocks of a modern vehicle, need for and degree of hybridization.
2. Analyze various drives suitable for electric and hybrid electric vehicles.
3. Learn about electric propulsion unit and design considerations of EVs and hybrids.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
5. Learn about Energy Management Strategies used in electric vehicles and hybrid vehicles.

**SYLLABUS:**

**Module-01:**

**[8 Hours]**

**Basics of Modern Vehicles:** History of hybrid and electric vehicles. Societal and environmental importance of fuel, electric and hybrid vehicles. Degrees of hybridization.

Conventional Vehicles: Features and sub-systems in a modern vehicle, Motion and dynamics equations for vehicles, Basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

**Module-02:**

**[8 Hours]**

**Electric vehicle drive-trains:** Basic concept of electric traction, Electric drive-train topologies and power flow analysis, electric components used in EVs, Configuration and control of DC Motor drives, induction motor drives, permanent magnet motor drives, switched reluctance motor drives. Drive system efficiency.

**Hybrid vehicle drive trains:** Basic concept of hybrid traction, degree of hybridization, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, energy efficiency analysis.

**Module-03:** **[8 Hours]**

**Power for Propulsion:** Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

**Design consideration for EV chassis and body:** Modularity in chassis, NVH level requirements, IP rating of drive train, configuration of traction device for damping,

**Module-04:** **[8 Hours]**

**Energy Storage:** Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis (charge-discharge rate and cycles limit), Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Regenerative braking, AC-DC converter.

**Module-05:** **[8 Hours]**

**Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of different energy management strategies, implementation issues of energy management strategies. Challenges in battery charging / swapping infrastructure. Grid connected energy transfer, wireless energy transfer.

**Case Studies: Design of a Plug-in Hybrid Electric Vehicle (PHEV), Design of a Battery Electric Vehicle (BEV), Design of Series-Parallel HEV Drive train**

**TEXT BOOKS:**

1. Electric and Hybrid Vehicles: Design Fundamentals, I. Husain, CRC Press, 2<sup>nd</sup> edition, 2010.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, CRC Press, 3<sup>rd</sup> edition, 2018.
3. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley, 2<sup>nd</sup> edition, 2012.

**REFERENCE BOOKS:**

1. Vehicular Electric Power Systems, A. Emadi, M. Ehsani and Jihn M. Miller, CRC Press, 1<sup>st</sup> edition, 2003.
2. Electric Vehicles: Prospects and Challenges, James Larminie and John Lowry, Wiley, 2<sup>nd</sup> edition, 2012.
3. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.

**COURSE OUTCOMES:**

1. Demonstrate the working of electric and hybrid electric vehicles.
2. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
3. Design and develop the propulsion system of electric vehicles and hybrid electric vehicles.
4. Choose proper energy storage systems for vehicle applications.
5. Analyze and model the power management systems for electric and hybrid vehicles.

**ONLINE RESOURCES:**

Course Name	Introduction to Hybrid and Electric Vehicles
Course Link	<a href="https://nptel.ac.in/courses/108/103/108103009/">https://nptel.ac.in/courses/108/103/108103009/</a>
Course Instructor	Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati

Course Name	Electric Vehicles
Course Link	<a href="https://nptel.ac.in/courses/108/102/108102121/">https://nptel.ac.in/courses/108/102/108102121/</a>
Course Instructor	Prof. Amit Kumar Jain, IIT Delhi

<b>Course Code:</b> <b>19EE6OE01T</b>	<b>Subject Name:</b> <b>Electrical Energy Utilization</b>	<b>L-T-P:</b> <b>3-0-0</b>	<b>Credit:</b> <b>3</b>
--	--	-------------------------------	----------------------------

### **COURSE OBJECTIVES:**

1. To understand the basic concepts of illumination systems
2. To understand the basic concept of design of lighting schemes
3. To understand the fundamental requirements of railway electrification
4. To understand the operation of refrigeration and air-conditioning control technique

### **SYLLABUS**

#### **Module-01 Illumination:**

**[8 Hours]**

Production of light - lighting calculations - determination of MHCP and MSCP - Polar curves of different types of sources - Rouseau's construction - photometers - interior and exterior illumination systems - lighting schemes - Design of lighting schemes - factory lighting – flood lighting - electric lamps - gaseous discharge lamps - high pressure and low pressure neon signs - high frequency, low pressure discharge tubes.

#### **Module-02 Electric furnaces and welding:**

**[7 Hours]**

Resistance, inductance and Arc Furnaces - Construction and fields of application – control equipment, high frequency dielectric heating, resistance - welding equipment - characteristics of carbon and metallic arc welding - butt welding - spot welding.

#### **Module-03 Electro-chemical processes:**

**[5 Hours]**

Electrolysis – Electroplating – Electro deposition – Extraction of metals Current, Efficiency - Batteries – types – Charging Methods.

#### **Module-04 Electric traction:**

**[8 Hours]**

Railway electrification – definition and analysis of traction effort – speed – time curve – traction motors - battery driven vehicles - energy efficiency drives – advanced speed control measuretractive effort calculations - electric braking - control wire - A.C. traction - recent trend in electric traction.

**Module-05 Refrigeration and air-conditioning:**

**[7 Hours]**

Control of temperature - basic wiring diagram - simple heat load and motor calculations.  
 Airconditioning - function of complete air conditioning system - type of compressor motor and fan motor-wiring diagram for a typical air conditioning unit.

**COURSE OUTCOMES:**

After completion of this course the students will be able to:

1. Students will be able to understand the basic concepts of illumination systems and concept of design of lighting schemes.
2. Students will be able to understand the construction and fields of application of resistance, inductance and arc furnaces.
3. Students will be able to assess the degree of adequacy level in electro-chemical processes in Industry.
4. Students can analyze problem related to railway electrification.
5. Students will understand the operation of refrigeration and air-conditioning control techniques.

**TEXT BOOKS:**

1. S. C. Tripathy, *Electric Energy Utilisation and Conservation*, Tata McGraw Hill , 1991
2. W. F. Stocker and J.W. Jones, *Refrigeration & Air Conditioning Refrigeration & Air Conditioning*, McGraw Hill , 1985

**REFERENCE BOOKS:**

1. C.L. Wadhwa, *Generation, Distribution & Utilization of Electrical Energy*, New Age , 1989
2. N.V. Suryanarayana, *Utilisation of Electric Power*, Wiley Eastern Ltd. , 1993

**DIGITAL LEARNING RESOURCES:**

Course Name	Illumination Engineering
Course Link	<a href="https://nptel.ac.in/courses/108/105/108105060/">https://nptel.ac.in/courses/108/105/108105060/</a>
Course Instructor	Prof. N.K.Kishore, Indian Institute of Technology Kharagpur

<b>Course Code:</b> 19EE6OE02T	<b>Course Name:</b> Introduction to Robotics and Autonomous Vehicles	<b>L-T-P</b> 3- 0- 0	<b>Credit :</b> 3
-----------------------------------	---	-------------------------	----------------------

### COURSE OBJECTIVE:

1. Gain basic knowledge on control and design of robotic system and its applications to solve common human society problems.
2. Will be able to gain knowledge on sensor technology and computer vision.
3. Knowledge on autonomous vehicle technology.
4. Will generate fundamental knowledge needed for the future technological advances that will be able to drive the economic engines of the society.

### SYLLABUS

#### Module-01:

#### **Introduction and Overview of Robotic Systems and their Dynamics [12Hours]**

Introduction. Construction of manipulators, advantages and disadvantages of various Kinematic structures. Applications, Non-servo robots, motion planning. Feedback systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, jacobian, work envelopes.

Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulate or dynamics and force control. Sensors: Vision, ranging, laser, acoustic, tactile.

#### **Module-02: Evolution of Automotive Electronics [8 Hours]**

Basic Control System Theory applied to Automobiles -Overview of the Operation of ECUs - Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems- Autonomous Vehicles

#### **Module-03: Sensor Technology for Autonomous Vehicles [8 Hours]**

Basics of Radar Technology and Systems -Ultrasonic Sonar Systems -LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters

**Module -04:**

**Computer Vision and Deep Learning for Autonomous Vehicles [7 Hours]**

Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing –Tensor Flow -Overview of Deep Neural Networks -Convolutional Neural Networks

**Module -05:**

**Autonomous Vehicle Technology [7 Hours]**

Driverless Car Technology-Different Levels of Automation -Localization, Unmanned Aerial Vehicle (UAV) Technology, Navigation, Path Planning, Path Following, Obstacle avoidance technology. Controllers to Actuate a Vehicle: PID Controllers -Model Predictive Controllers.

**COURSE OUTCOMES:**

After completion of this course the students will be able to:

1. Gain the knowledge on robotics and its applications to operate autonomous vehicles
2. Explain the applications of controllers in the field of robotics
3. Gain depth knowledge Sensor Technology and computer vision
4. Gain knowledge in different types of motor drives
5. Explain different applications of Deep Learning for Autonomous Vehicles
6. Describe the Technology of Autonomous Vehicle including the design and path planning

**TEXT BOOKS:**

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
2. R Kelly, D. Santibanez, LP Victor and Julio Antonio, “Control of Robot Manipulators in Joint Space”, Springer, 2005.
3. Hong Cheng, “Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation”, Springer, 2011.
4. Williams. B. Ribbens: “Understanding Automotive Electronics”, 7th Edition, Elsevier Inc, 2012.

**REFERENCE BOOKS:**

1. Shaoshan Liu, Liyun Li, “Creating Autonomous Vehicle Systems”, Morgan and Claypool Publishers, 2017.
3. Marcus Maurer, J.Christian Gerdes, “Autonomous Driving: Technical, Legal and Social Aspects” Springer, 2016.
4. Ronald. K .Jurgen, “Autonomous Vehicles for Safer Driving”, SAE International, 2013.
5. James Anderson, KalraN idhi, Karlyn Stanly, “Autonomous Vehicle Technology: A Guide for Policymakers”, Rand Co, 2014.
6. Lawrence. D. Burns, Chrostopher Shulgan, “Autonomy – The quest to build the driverless car and how it will reshape our world”, Harper Collins Publishers, 2018.

**DIGITAL LEARNING RESOURCES**

Course Name	Introduction to Robotics
Course Link	<a href="https://nptel.ac.in/courses/107/106/107106090/">https://nptel.ac.in/courses/107/106/107106090/</a>
Course Instructor	Prof. Asokan T, Indian Institute of Technology Madras

<b>Course Code:</b> 19CE6OE01T	<b>Course Name:</b> Plastic Waste Management	<b>L-T-P</b> 3- 0- 0	<b>Credit :</b> 3
-----------------------------------	---	-------------------------	----------------------

**COURSE OBJECTIVE:**

1. To know the sources of plastics
2. To know plastic waste management system
3. To know the recycling of waste plastic.
4. To know the plastic waste management practices.
5. To know about the biodegradable plastics.

**Module: 01** **(08 hrs)**

Plastics –What it is? Types, Uses and Global Statistics, Plastic Waste –Sources, Production, Global and Indian Context, Plastic Waste Management Rules 2016 (India) and Global Rules and Regulations

**Module: 02** **(08 hrs)**

Plastics waste management-4 R & I approach viz. Source reduction, Reuse, Repair, Recycling, and Incineration with examples. Plastics recycling, Classification Code of practice-Primary, secondary, tertiary and quaternary recycling with examples-Coextrusion and co-injection moulding-Waste plastics as fillers.

**Module: 03** **(08 hrs)**

Mechanical recycling of commonly used plastics, such as PP, PE, PET, etc. mixed waste recycling-co-extruded films waste, commingled waste extrusion flow moulding for production of plastics lumbars, chemical recycling/feed Stochrecycling processes for recovery of oil, monomer and energy-thermolytic processes. Solvolysis-process outline for PMMA, PET, etc.

**Module: 04** **(08 hrs)**

Plastic Waste Management Practices –Use of Plastic waste in roads, issues and challenges, Possible Alternate Materials to Plastics –Greener Alternatives, Plastics Resource Recovery and Circular Economy, Plastic Bans including China Sword Policy implication on global plastic waste

management, Impact of Plastics on Marine Life, Effect on Wildlife, Human Health and Environment.

**Module: 05** **(08 hrs)**

Biodegradable plastics-an overview. Environmental issues, policies and legislation in India.  
 Plastics-Energy saving, Eco-Friendly-Case studies. Life cycle analysis-a model.

**COURSE OUTCOME:**

After completion of the course the student can

1. Students will able to explain the sources of plastics.
2. Students will be able to explain the plastic waste management.
3. Students will be able to explain the recycling process of plastic.
4. Students will able to explain waste management practices.
5. Students will able to explain biodegradable plastics.

**TEXT BOOKS:**

1. R.J. Brandrup, *Recycling and recovery of plastics*, First Edition, Hanser Publishers, 1996 New York
2. N. Mustafa, *Plastics Waste Management, Disposal Recyding and Reuse*, First Edition, Marcel Dekker, Inc. 1993, New York.

**REFERENCE BOOKS:**

1. L. Andrady, *Plastics and the Environment*, First Edition Wiley Inter science, 2003, New York.
2. R.J. Ehrig, *Plastics Recycling, Products and Processes*, First Edition Hanser Publishers, 1992, New York.
3. *Technologies in Plastics Recycling*, American Chemical Society, Washington, DC 1992.

**DIGITAL LEARNING RESOURCES**

Course Name	Plastic Waste Management
Course Link	<a href="https://nptel.ac.in/courses/105/105/105105184/">https://nptel.ac.in/courses/105/105/105105184/</a>
Course Instructor	Prof. B. K. Dubey, Department of Civil Engineering, IIT Kharagpur

<b>Course Code:</b> 19CE6OE02T	<b>Course Name:</b> Environment and Safety Engineering	<b>L-T-P</b> 3- 0- 0	<b>Credit : 3</b>
-----------------------------------	---	-------------------------	-------------------

**COURSE OBJECTIVE:**

1. Convey ideas of the interdisciplinary nature of environment
2. Characterization of water and wastewater including basic design
3. To aware of the basic concepts of safety
4. Ability to assess safety in various places

**Module: 01** **(08 hrs)**

Environmental Engineering: Introduction to Environmental engineering Nature and scope of environment problems Ecosystem effects through bio-geochemical cycles Local, regional and global environmental challenges, Basic concepts of biodiversity and its significance, human behavior and values for a sustainable society Water Pollution Fundamentals and Control Strategies

**Module: 02** **(08 hrs)**

Water quality-physical, chemical & biological characteristics, drinking water standards Effluent quality requirements Water and wastewater treatment processes-treatment train, physical, chemical and biological unit operations Air Pollution Fundamentals and Control Strategies: Air pollution - sources, classifications and regulations indoor air pollution, air pollutants and their effects, Monitoring Principles and instrumentation for particulate and gaseous pollutant measurements

**Module: 03** **(08 hrs)**

Waste Minimization: Concept, Principles in Waste Management, LCA, Benefits of Waste Minimization, Elements of a Waste minimization Programme, Waste Reduction Technique. Environment Impact Assessment: Origin, Aims and Procedure of EIA, Project Screening for EIA, Preparation and Review of EIS, Limitation of EIA.

**Module: 04** **(08 hrs)**

Industrial Safety: Introduction, key concepts, terminologies, and safety quantification, safety by design, Hazard identification techniques, Fault tree and event tree analysis (qualitative &

quantitative), Safety function deployment, Occupational Safety and Health Acts, Industrial Safety Improvement Audit as per IS 14489 –Code of Occupational Safety and Health, Safety procedures,

**Module: 05**

**(08 hrs)**

Type of Accidents, Chemical and Heat Burns, Prevention of Accidents involving Hazardous substances, Human error and Hazard Analysis. Hazard Control Measures. Fire Prevention – Detection, Extinguishing Fire, Electrical Safety, Product Safety. Safety. Management-Safety Handling and Storage of Hazardous Materials, Corrosive Substances, Gas Cylinders, Hydro Carbons and Wastes. Personal Protective Equipment. Road Safety Audit

**COURSE OUTCOME:**

After completion of the course the student can

1. Capable to assess environmental pollution level
2. Can design water treatment units
3. Identify and solve occupational safety and health problems
4. Ability to apply the fundamental knowledge of environmental engineering to assess environmental and risk Demonstrate the site investigation, methods and sampling.

**TEXT BOOKS:**

1. H. S. Peavy, D. R. Rowe, and G.Tchobanoglous, *Environmental Engineering*, First Edition McGraw Hill Education, 2017.
2. Noel de nevers, *Air Pollution Control Engineering*, Second Edition, McGraw Hill. Education, 1999.
3. Environmental Engg. & Safety by Prof B.K. Mohapatra, Seven Seas Publication, Cuttack

**REFERENCE BOOKS:**

1. W Eckenfelder, Jr, *Eckenfelder Industrial Water Pollution Control*, McGraw-Hill Science
2. G Kiely, *Environmental Engineering*, McGraw Hill Education

**DIGITAL LEARNING RESOURCES**

Course Name	Industrial Safety Engineering
Course Link	<a href="https://nptel.ac.in/courses/110/105/110105094/">https://nptel.ac.in/courses/110/105/110105094/</a>
Course Instructor	Dr. Jhareswar Maiti, Professor, IIT Karagpur

# Laboratory Course

<b>Subject Code:</b> <b>19EC6PC02L</b>	<b>Subject Name:</b> <b>MICROWAVE ENGINEERING LABORATORY</b>	<b>L-T-P:</b> <b>0-0-3</b>	<b>Credit:</b> <b>2</b>
---	---	-------------------------------	----------------------------

**(Any Ten of the following experiments are to be performed with X-band/S-band/Ku-band Microwave components)**

1. Study of Microwave components and Instruments
2. Measurement of Reflex Klystron Characteristics
3. Study of V-I characteristics of Gunn Diode
4. Measurement of Insertion loss, Directivity, Coupling Coefficient and Isolation of a Directional Coupler
5. Determination of Radiation Pattern and gain of a Horn Antenna
6. Measurement of Dielectric Constants (Teflon, Nylon)
7. Determination of Phase shift of a Phase Shifter
8. Calibration of the attenuation constant of an Attenuator
9. Measurement of Voltage Standing Wave Ratio (VSWR) and reflection Coefficient
10. Scattering parameters of Circulator/Isolators
11. Impedance, Wavelength and Frequency Measurement
12. Measurement of Scattering Parameters
13. Coupling Measurement of H-plane, E-Plane and Magic Tee junctions

<b>Subject Code:</b> <b>19EC6PC01L</b>	<b>Subject Name:</b> <b>DIGITAL COMMUNICATION TECHNIQUES</b> <b>LABORATORY</b>	<b>L-T-P:</b> <b>0-0-2</b>	<b>Credit:</b> <b>1</b>
---	--	-------------------------------	----------------------------

**LABORATORY EXPERIMENTS:**

1. Design and analysis of Delta modulation and demodulation.
2. Design and analysis of Adaptive Delta modulation and demodulation.
3. To study Time division multiplexing.
4. To study the different channel coding and decoding technique.
5. Generation and reception of different types of signals like ASK, PSK, FSK.
6. Experimentally compare different forms of QPSK modulation.
7. Generation and reception of Differential Phase shift keying (DPSK).
8. Generation and reception of Minimum shift keying (MSK).
9. Experimentally compare different forms modulation by analyzing their spectrum using spectrum analyzer.
10. Simulate and compare ASK, PSK and FSK modulation using MATLAB.
11. Simulate and compare QPSK, OQPSK and DPSK modulation using MATLAB.

**COURSE OBJECTIVES [COB]**

COB	Objectives
1.	Make acquainted the students with basic analog-to-digital communication techniques.
2.	Familiarize students with various digital modulation and demodulation techniques
3.	To get acquainted with various digital data communication network

**COURSE OUTCOMES [CO]**

On Completion of this Subject/ Course the students should be able to:

CO	Outcomes
1.	To analyze and perform various analog to digital conversion technique
2.	To be able to understand and analyze different digital modulation techniques in time as well as in frequency domain.
3.	To get in hand exposure in understanding the data transmission in various digital networks.
4.	Analyze and design various digital modulation techniques using MATLAB

<b>Subject Code:</b>	<b>Subject Name:</b>	<b>L-T-P:</b>	<b>Credit:</b>
<b>19CM6PS01L</b>	<b>RESEARCH/LAB BASED PROJECT</b>	<b>0-0-3</b>	<b>2</b>

It's a Product Development Lab-II

Students need to do one project based on prototype / hardware development as decided by the department.

<b>Subject Code:</b> <b>19CM6HS01L</b>	<b>Subject Name:</b> <b>BUSINESS COMMUNICATION &amp; INTERVIEW SKILLS</b>	<b>L-T-P:</b> <b>0-0-3</b>	<b>Credit:</b> <b>2</b>
---	--	-------------------------------	----------------------------

This is an activity based course that has been specifically designed to cater to the needs of the Pre-Final Year (6<sup>th</sup> Semester) students. This course will aim at preparing and facilitating the students for the Interview and its related activities. There will be ten labs, all of which deal with various aspects and stages of Interview.

**LAB 1 :** Ice breaking, Professional Introduction

**LAB 2 :** Professional Introduction, Professional Ethics

**LAB 3 :** Non-verbal aspects in an Interview/a G.D./Meeting, Business/Professional Etiquette

**LAB 4 :** Team Management Skills

**LAB 5 :** Leadership and Managerial Skills

**LAB 6 :** Time and Stress Management

**LAB 7 :** Present yourself in the context of your dream company

**LAB 8 :** Present yourself in the context of your dream company (cont....)

**LAB 9 :** Basics of drafting a Job Application and Resume

Fundamental differences between CV/Resume/Bio data

**LAB 10:** Summarizing Reviewing Final Resume and Job Application of students